



# Climate Change and the EPA National Water Program

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**Office of Water**  
**U.S. EPA**

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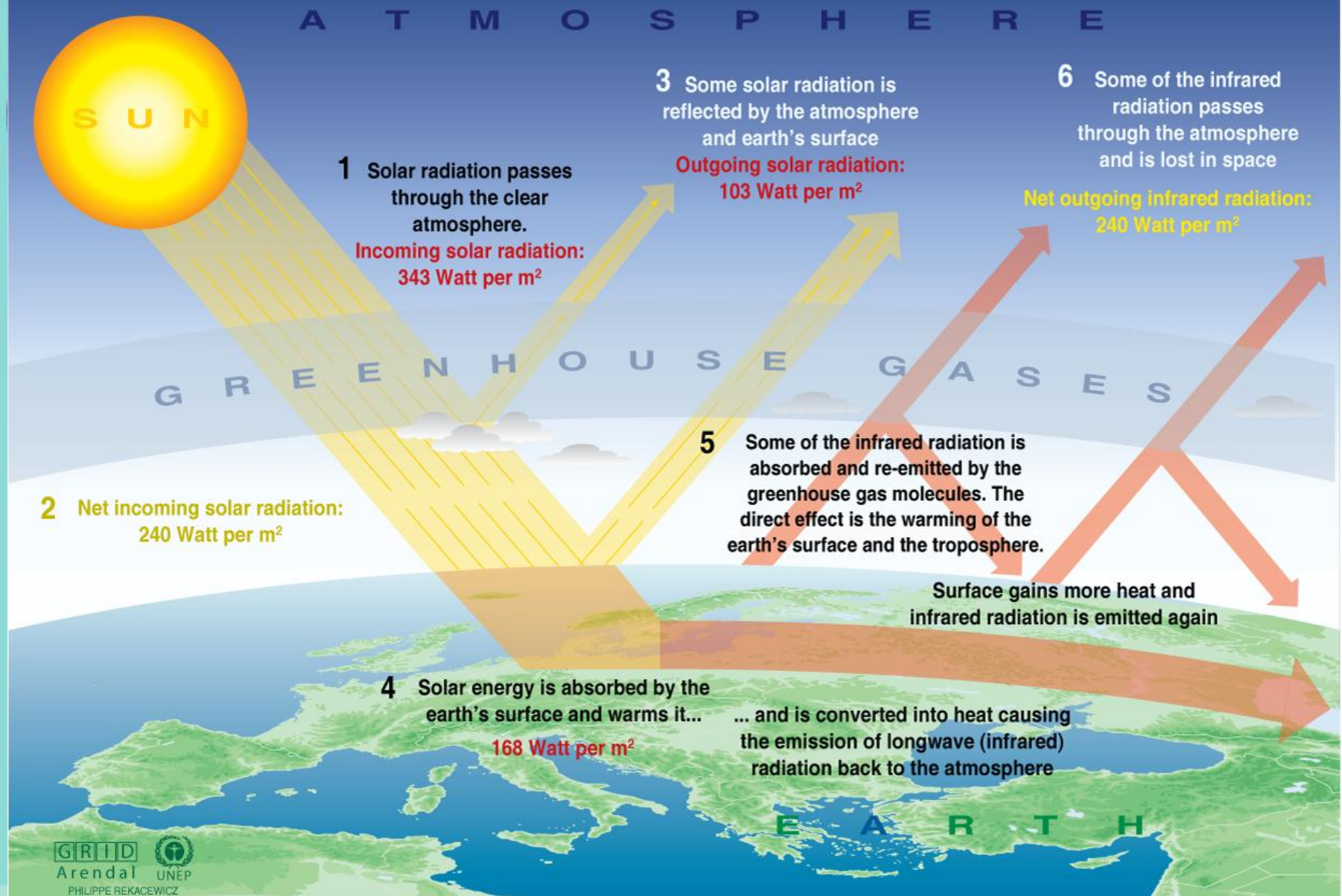




# Climate Change and Water Resources

1. Climate change basis
2. Impacts on water resources
3. Adaptation and Mitigation

# The Greenhouse effect



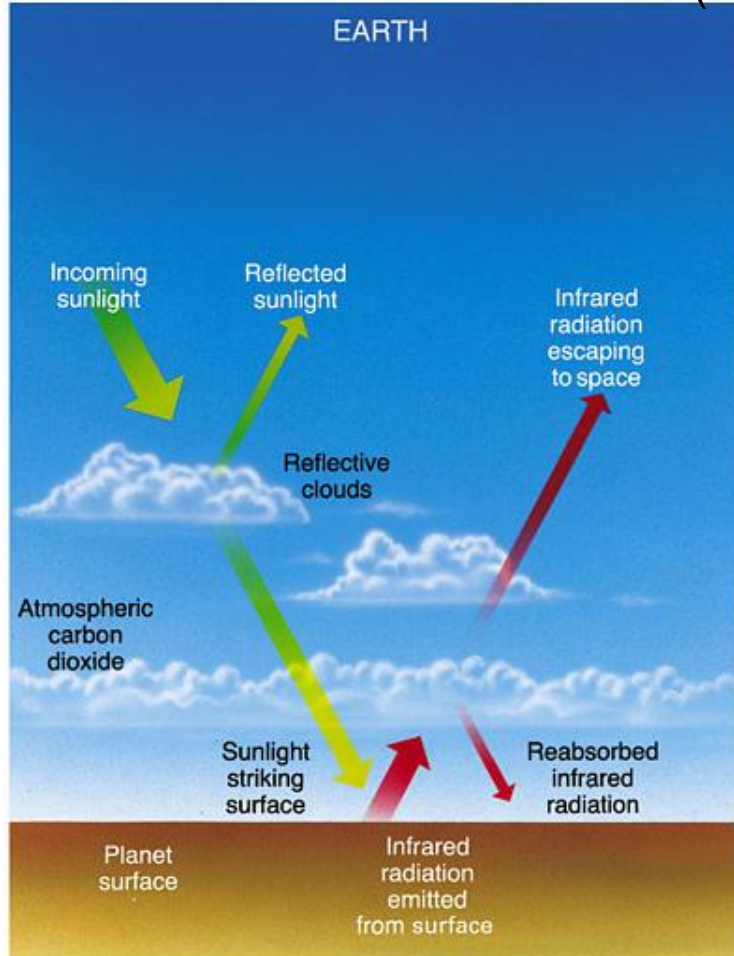


# What is the Cause of Climate Change?

## The Greenhouse Effect: Role of GHG

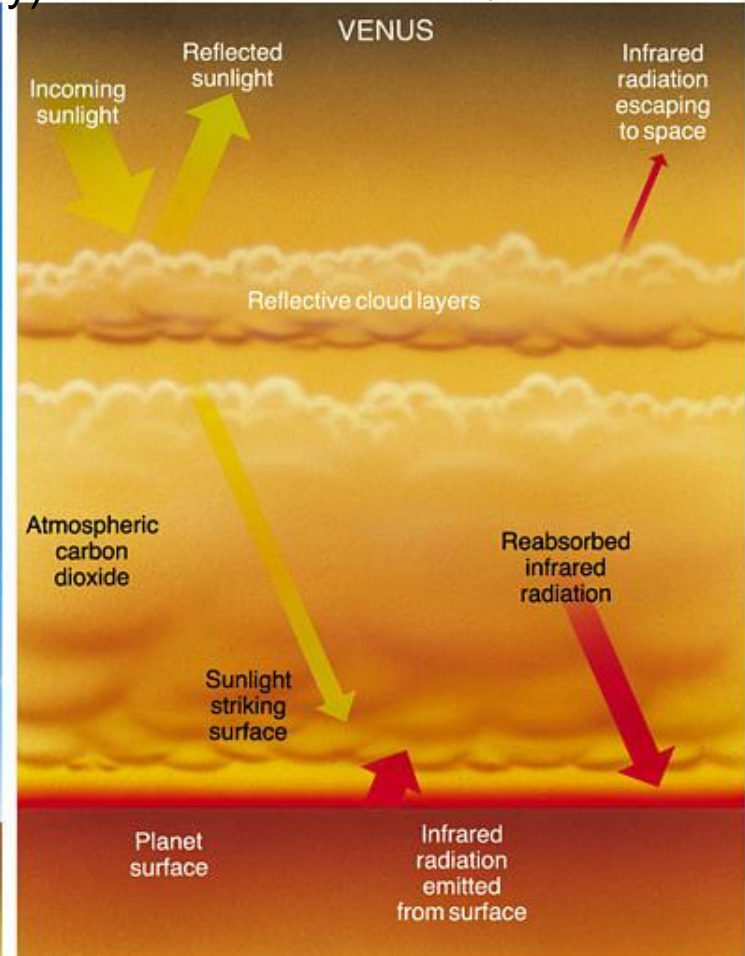


• <1% CO<sub>2</sub> and other GHGs (dry)



Surface Temp: 300K

• 96.5% CO<sub>2</sub> by volume

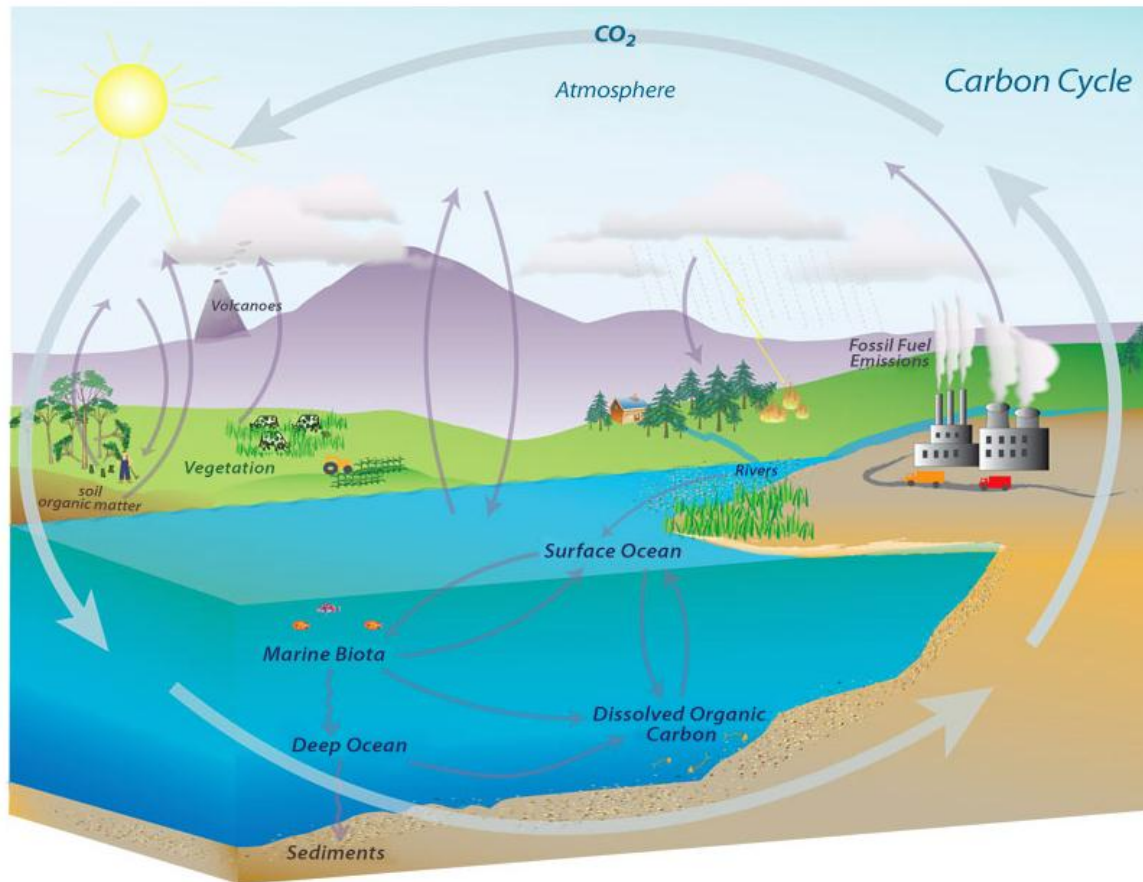


Surface Temp: 750K

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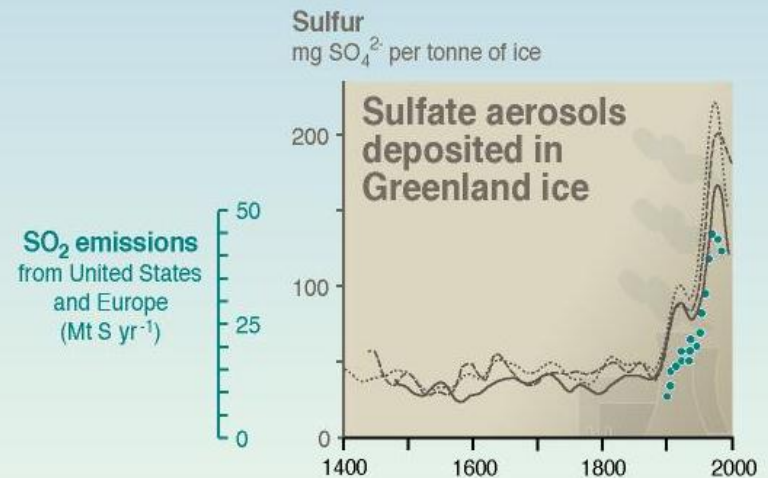
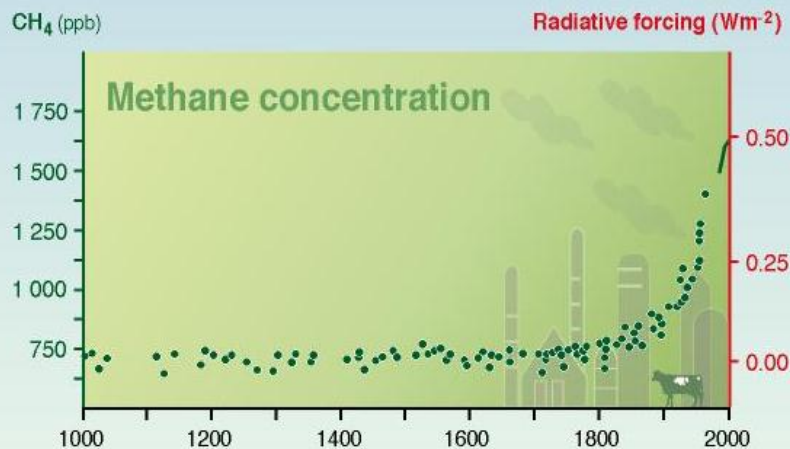
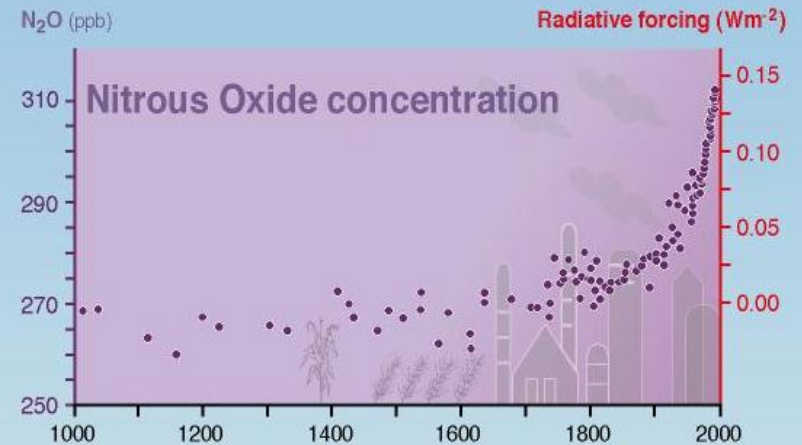
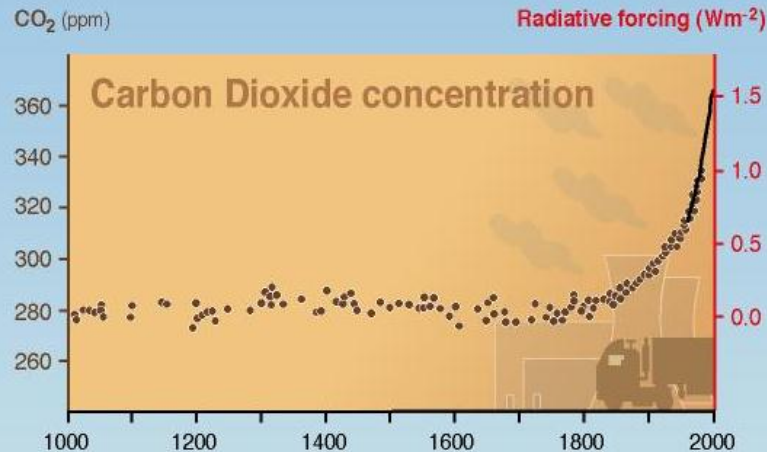
# What is the Cause of Climate Change?

## The Global Carbon Cycle



Source: NOAA , [www.esrl.noaa.gov](http://www.esrl.noaa.gov)

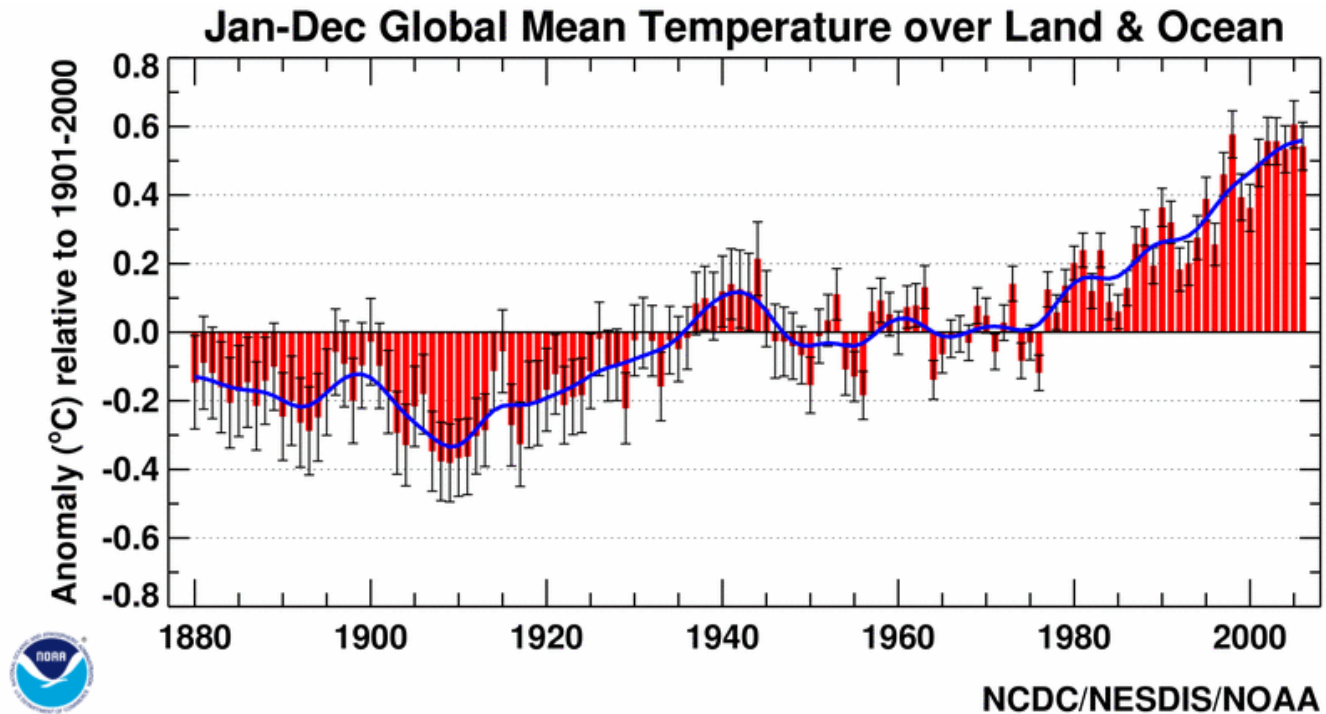
## Indicators of the human influence on the atmosphere during the Industrial era





# *How Is the Climate Changing?*

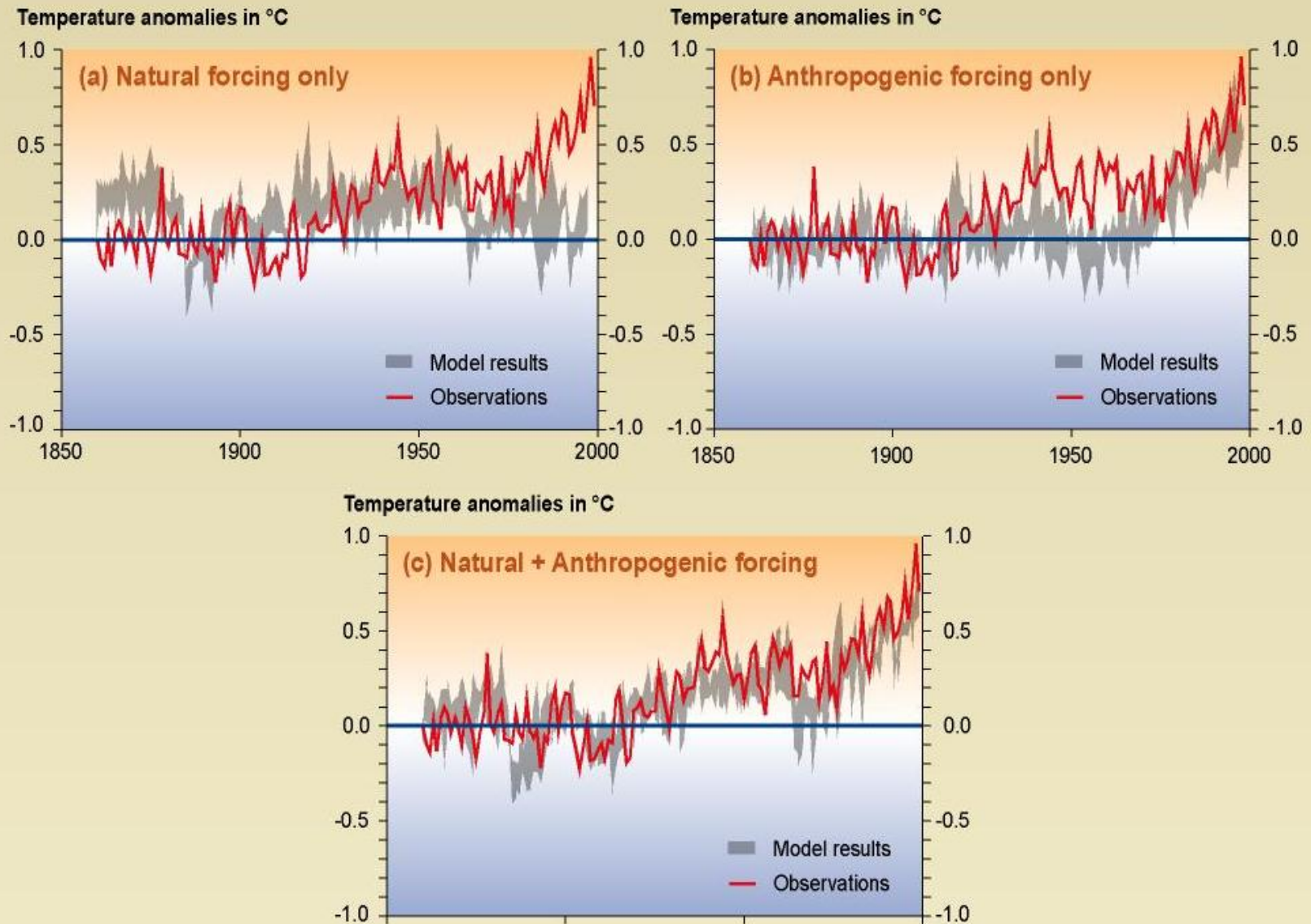
## Observed Temperature Changes



**Annual Average Global Surface Temperature Anomalies  
1880-2006**

8 of the 10 warmest years on record have occurred since 2001.

## Comparison between modeled and observations of temperature rise since the year 1860



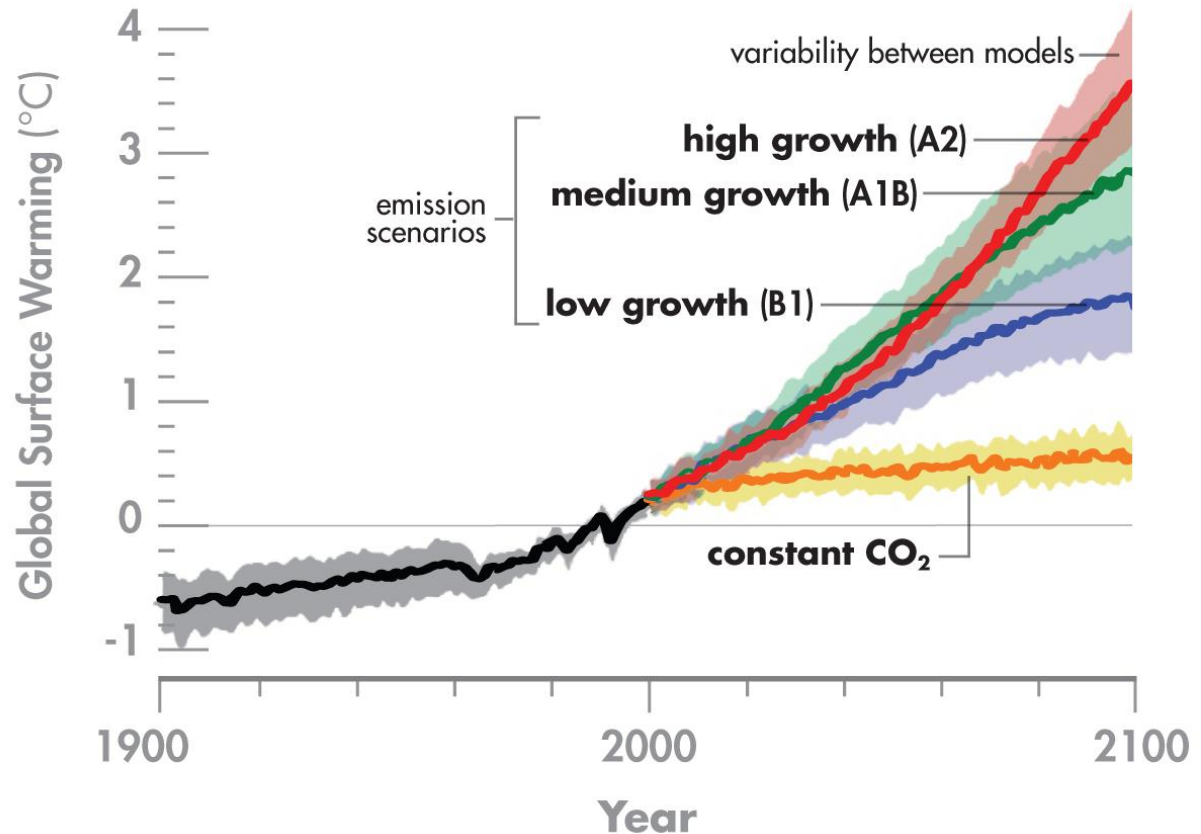


# How Is the Climate Changing?

## Projected Temperature Change



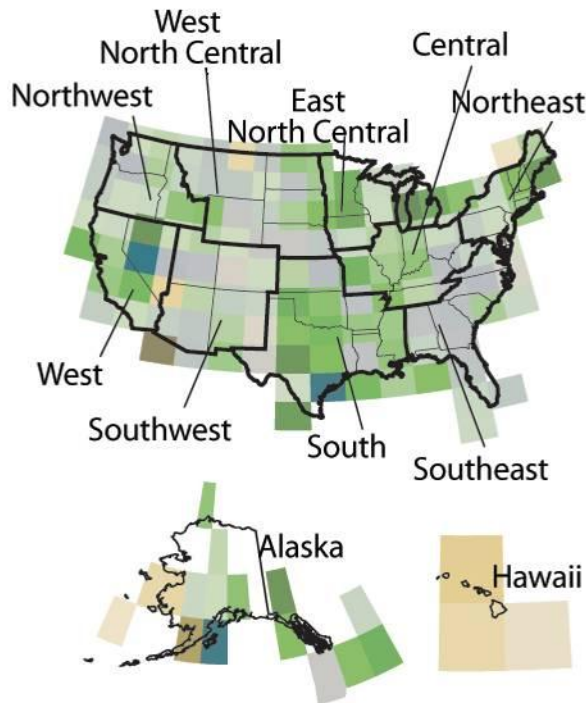
- Note all paths increase
- All paths agree up to ~2030
- All within 3-7° F over next century
- ADAPTATION



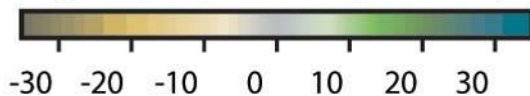


# Impacts: *How Is the Climate Changing?*

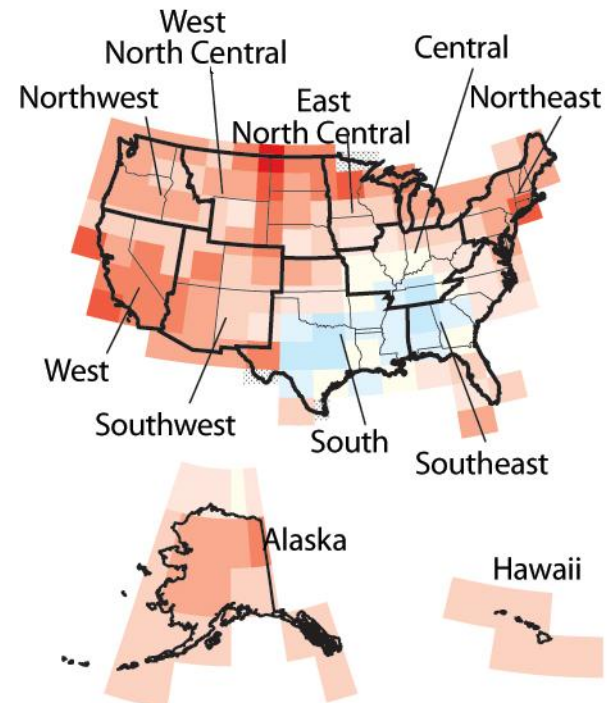
Annual Precipitation Trends 1901-2005



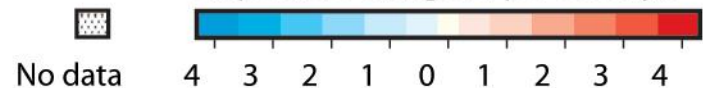
Change in precipitation (% per century):



Annual Mean Temperature Anomalies 1901-2005

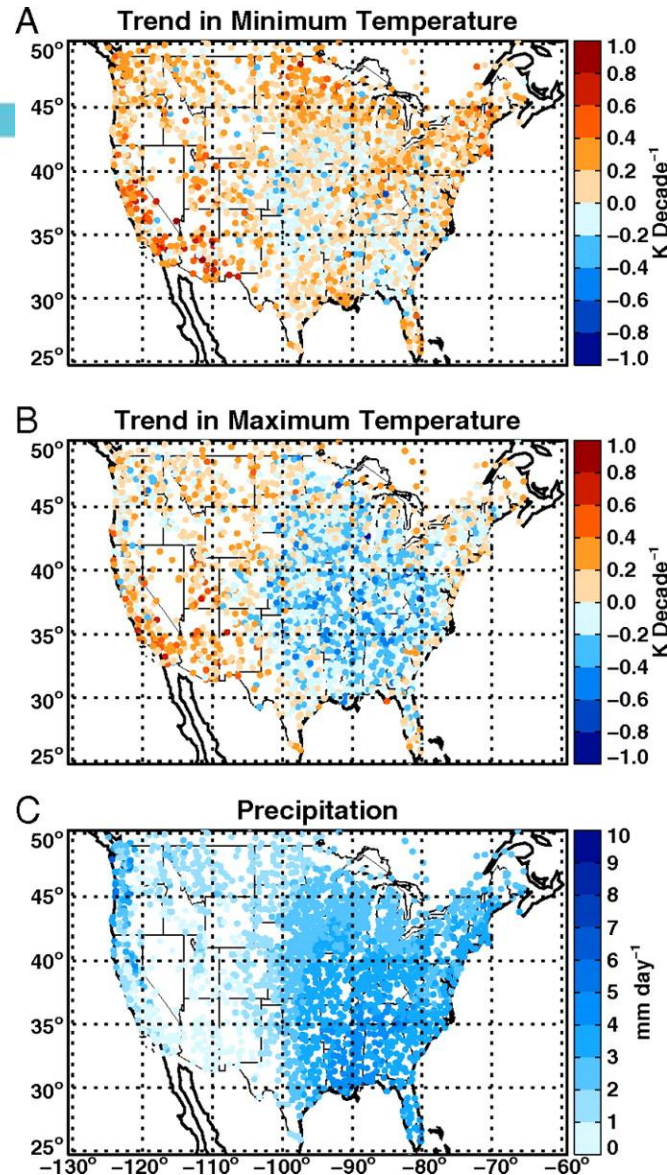


Temperature change (°F per century):



# How Is the Climate Changing?

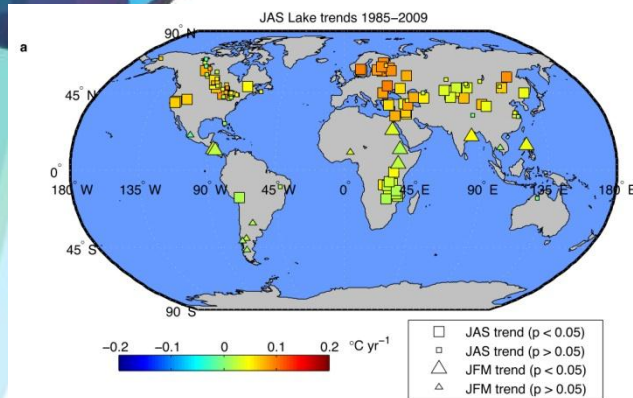
## Observed Temperature Changes



Maps of 1950–2006

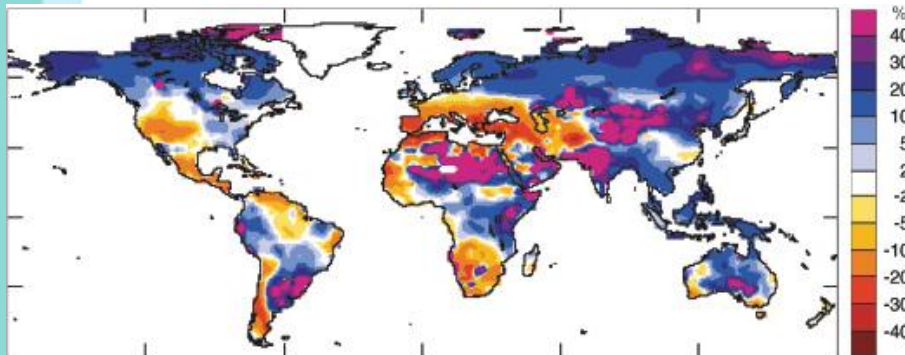


# *It's not just in the thermostat....*



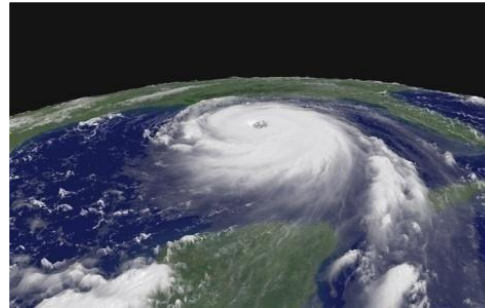
Source: NASA, Schneider and Hook, 2010

## **Warmer water**



Source: Milly et al., 2005

## **Precipitation changes**



Source: NOAA, [www.katrina.noaa.gov](http://www.katrina.noaa.gov)

## **Increases in tropical storm intensity**



Source: USEPA, [www.epa.gov/cre](http://www.epa.gov/cre)

## **Ocean and coastal changes**



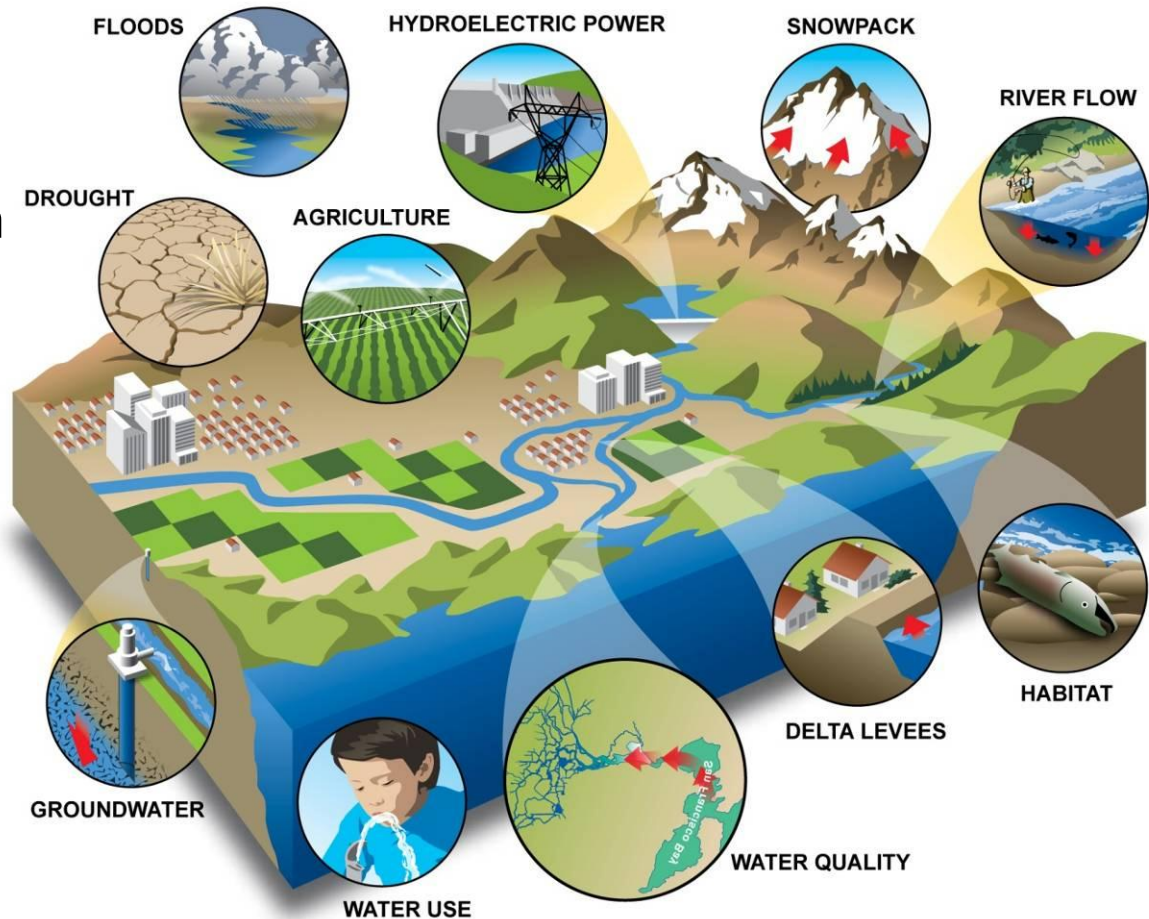
Source: Maps of Lands Vulnerable to Sea Level Rise as found in EPA 2008u

## **Sea level rise**

# *Why Does Climate Change Matter to Water Program Managers?*



- Temperature change drives other changes in natural environmental processes that in turn affect the quality and quantity of our water resources.
- Steps taken to reduce the release of greenhouse gases may have consequences for water resources and programs.



Source: California – Department of Water Resources. Climate Change in California Fact Sheet.

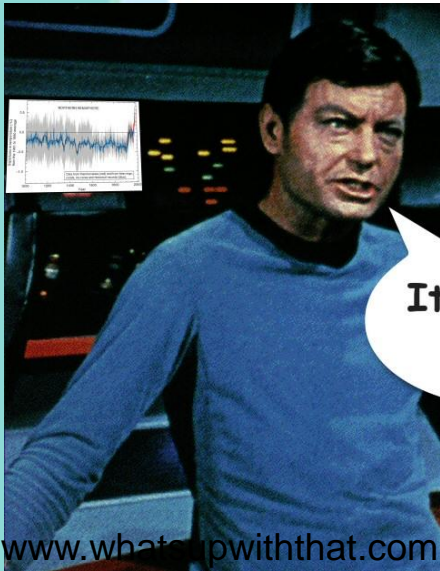
# Impacts on Water Management:

***“Stationarity Is Dead: Whither Water Management”***



**Translation:**

***“The past is no longer a guide for the future”***



It's dead  
Jim

***“Climate change undermines a basic assumption that historically has facilitated management of water supplies, demands, and risks.” – Milly et al., 2008***



# *The Effect on Water Resources*

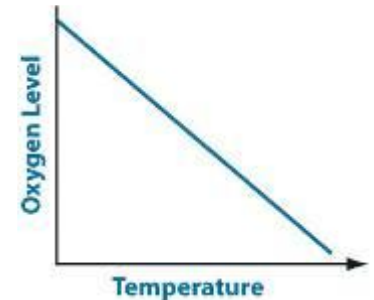
## **Water Temperature Increases**



**Changes in the  
distribution and survival  
of aquatic species**



**Water Quality: Algal blooms**



**Water Quality:  
Lower dissolved  
oxygen levels**

# *The Effect on Water Resources*

## **Precipitation Changes**



### Water quantity

- Reduced ground water and surface water supply in some areas
- Reduced reliability of snow pack as a water 'reservoir'
- Increased water demand due to higher temperatures



### Water quality

- Increased runoff resulting in erosion and sedimentation
- Overwhelmed water infrastructure due to flooding

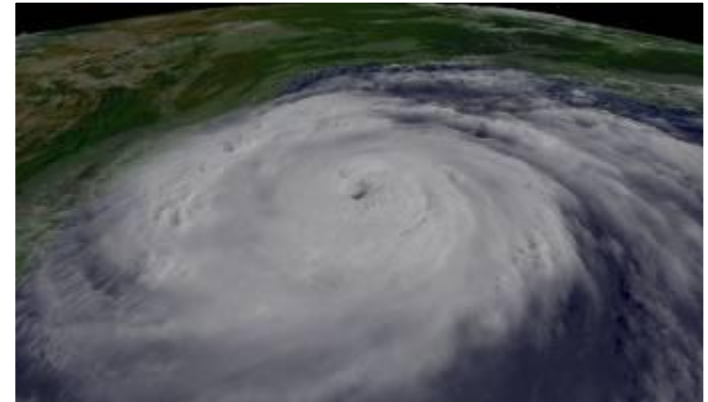


# *The Effect on Water Resources* **Increases in Storm Intensity**



Warming air and sea surface temperatures are expected to result in greater intensity of tropical storms, accompanied by:

- Stronger peak winds
- Increased rainfall
- Larger storm surges



**Intensified hurricanes and tropical storms**



# *The Effect on Water Resources* **Increases in Storm Intensity**



**Contaminated waters**



**Damaged wetlands**



Source: Louisiana DEQ

**Flooded Wastewater  
Treatment Plant**



**High wind damage**

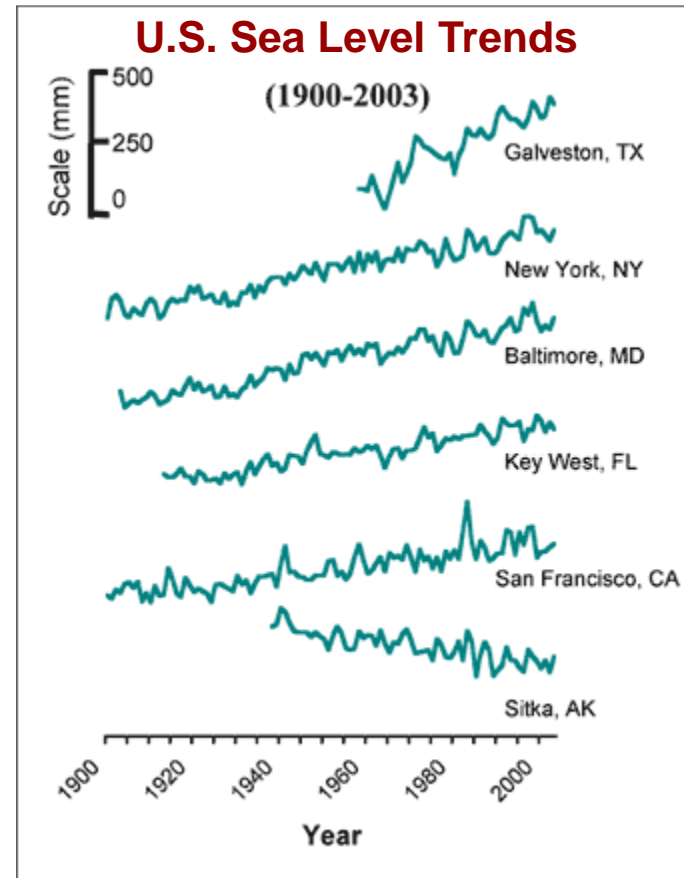
# *The Effect on Water Resources*

## **Sea Level Rise**



**“Sea levels are rising worldwide and along much of the U.S. coast.”**

**– IPCC, 2007c**



Source: Monthly and Annual Mean Sea Level Station Files from the Permanent Service for Mean Sea Level (PSMSL) at the Proudman Oceanographic Laboratory

# ***The Effect on Water Resources***

## **Sea Level Rise**



- Displacement of coastal wetlands and habitat
- Increased coastal erosion
- Salt water intrusion in drinking water supplies
- Inundation of wastewater treatment infrastructure





# *The Effect on Water Resources*

## **Ocean and Costal Changes**



- Biological habitat changes are expected in the oceans as the air temperatures increase
- Estuarine waters become more saline as sea levels rise
- Ocean temperatures increase
- Ocean acidification





# ***Energy, Water Resources and Climate Change***

- Reduced water flows could limit hydropower and power plant cooling
- Geological sequestration of CO<sub>2</sub> from coal-fired power plants could pose a risk to underground sources of drinking water
- Demand for biofuels could lead to increased agricultural nutrient runoff
- Water collection, treatment and distribution accounts for 4% of energy use in the U.S.



**Coal-fired electric power plant**



# *Water Quality Program Relevance*

## Example Considerations

- Reference conditions?
- Designated uses?
- Design flows? (e.g., 7Q10s)
- TMDLs?







# *EPA Strategies: Mitigation and Adaptation*



*“Climate change will affect other parts of our core mission... and we must include those considerations in our future plans.”*

- Lisa P. Jackson,
- Administrator, U.S. EPA

# *Greenhouse Gas Mitigation Strategies*



- WaterSense – Residential water efficiency
- Water reuse, leak detection
- Energy efficiency/energy generation at treatment plants
- Geological Carbon Sequestration





# *Adaptation Strategies*

*Adapt base programs and provide information, tools and assistance to States, Tribes and local governments*

- Climate Ready Estuaries
- Climate Ready Water Utilities & Vulnerability Assessment Tools
- Green Infrastructure/Low Impact Development
- State Revolving Funds – Green Set-aside
- Underway: Nutrient Criteria, Hydrologic criteria, Health risks, Coastal Wetlands Initiative....





# ***CRE- King Tides Project:*** ***Unusually high water levels***



- preview how sea level rise will affect coastal places
- help communicate about sea level rise

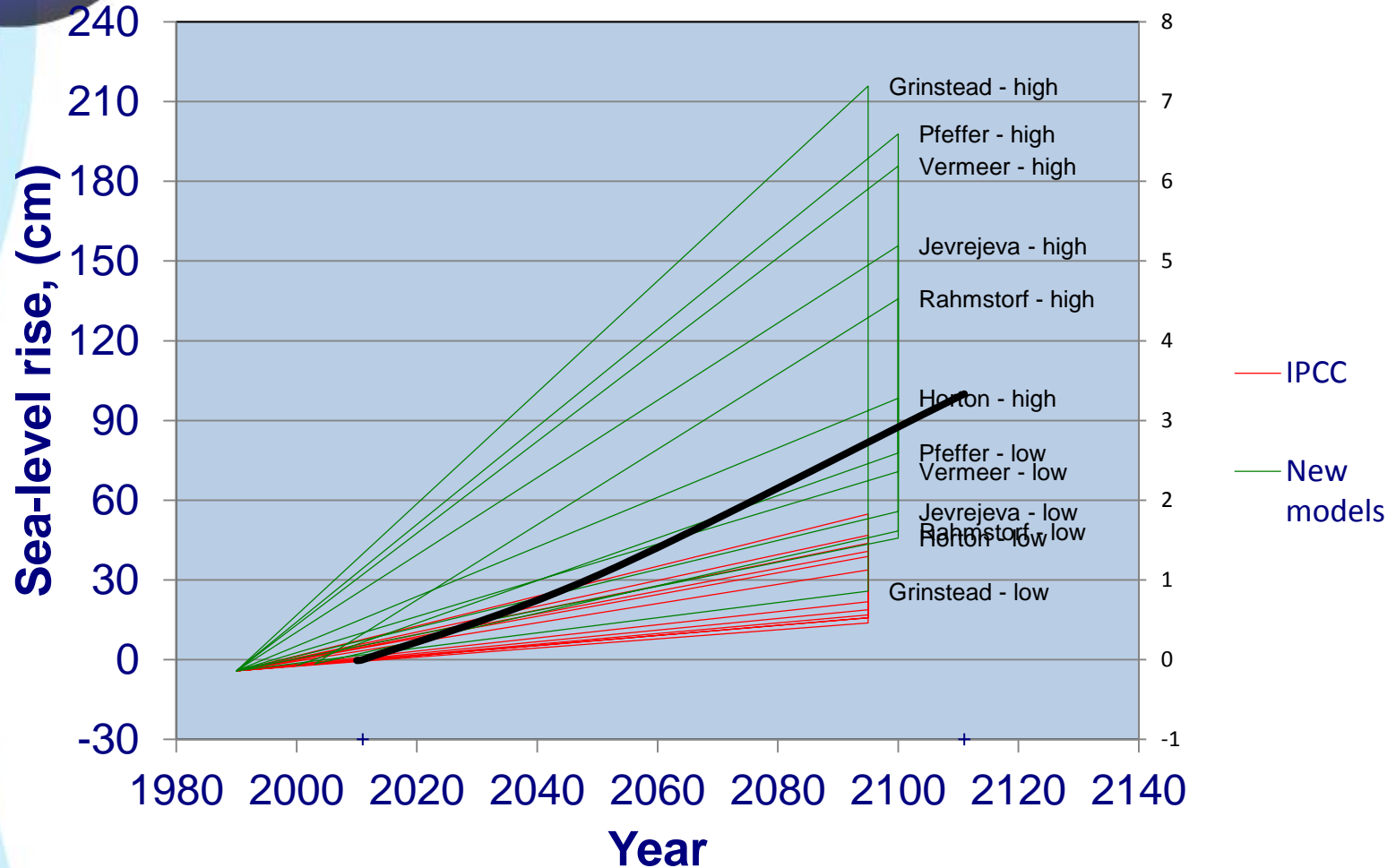


*•A typical day [left] and high water flooding [right] in Washington, DC.*



# When will King Tides become everyday tides?

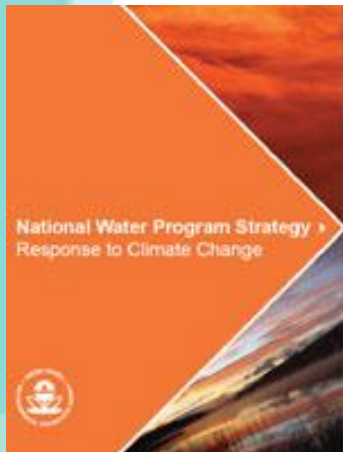
## 21st Century Sea Level Projections





# *Research, Education & Management Strategies*

- Office of Research and Development studies and Tools
  - 20 Watersheds Study
  - BASINS-CAT, SWIM-CAT, CAT-CAT
- Climate Seminar Series, Webinars, Webcasts, E-Newsletter
- NWP Climate Strategy
  - Update Actions for 2010-2011
  - Revise for 2012 and Beyond...







# Review

- Climate change will affect water resources and our water programs
- Climate change will affect every aspect of our national water program
- We need to use risk management to adapt while building understanding: iterative and flexible approach
- Don't assume stationarity: Adaptation



## ***For More Information***

**EPA Office of Water**

**[www.epa.gov/ow/climatechange](http://www.epa.gov/ow/climatechange)**

U.S. ENVIRONMENTAL PROTECTION AGENCY  
Office of Water





# Supplementary Slides

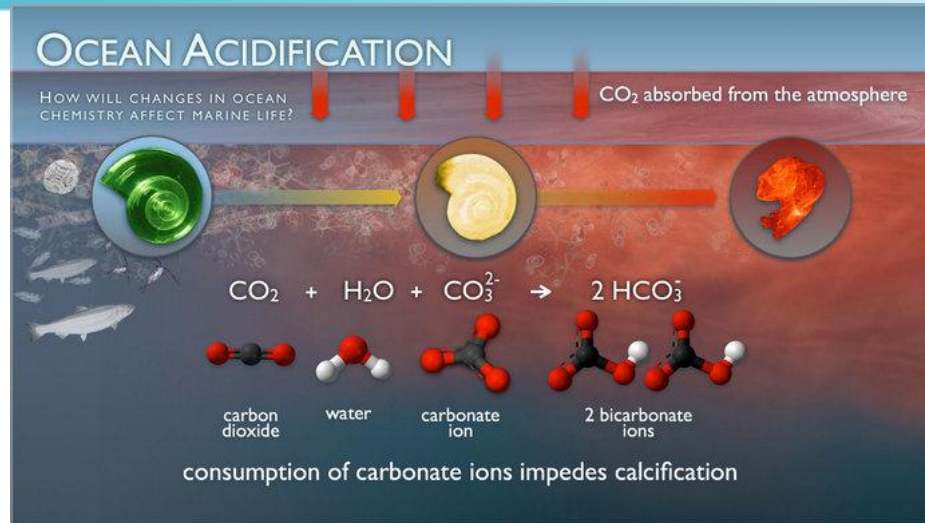
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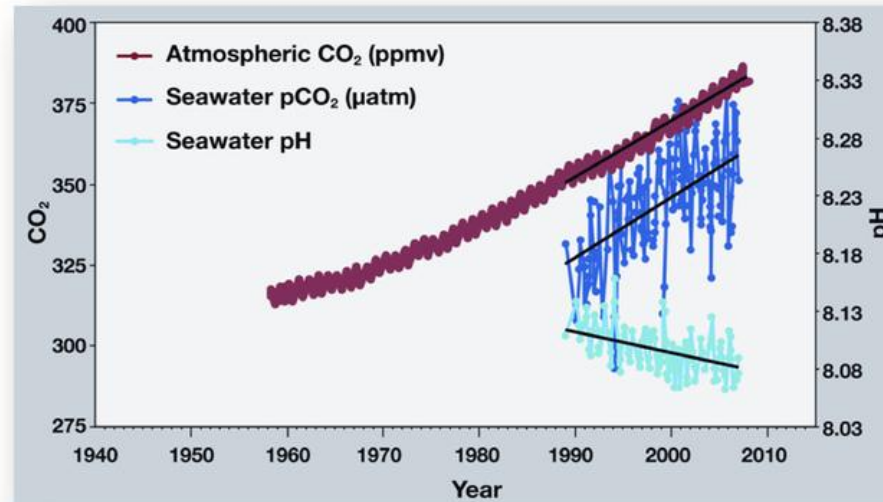


# Ocean Acidification

- Mechanism



- Correlation



•Feely, 2008



## ***EPA Regions***

- Each Region has a variety of activities underway
  - Use of the SRFs to promote energy efficiency & green infrastructure
  - Climate Ready Estuaries
  - Carbon sequestration
  - Workshops to education and collaborate
  - Etc.
- Several are working with Federal, State, Tribal and local partners to develop local capacity for adaptation



# *Interagency Activities*

- CEQ Interagency CC Adaptation Task Force
  - Water Workgroup - one of 12 workgroups
    - Water efficiency Team
    - IWRM Team
    - Vulnerability Assessment & Tools Team
    - Data and Models Team
    - Outreach, Education, Mainstreaming Team
- Public Lands Act Report to Congress (March '11)
- Climate Change & Water WG (CCAWWG)
  - USGS, ACoE, BuRec, NOAA, EPA, FEMA